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HANDBOOK ON WIND ZONING
For Municipal Officials

COLLECTION
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Executive Office of Energy Resources

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TABLE OF CONTENTS

ILLUSTRATIONS

I. INTRODUCTION

The interest in wind as an alternative source of energy has grown dramatically over the past few years. The reasons for its rise in popularity are fairly obvious, namely the rising cost of oil and gas and the resulting huge increases in fuel adjustment charges on electricity bills. People are struggling to find alternate means of heating and producing electricity for their homes, and wind along with conservation, solar energy and wood or biomass is an option which they are considering seriously. Along with those other alternatives, wind is attractive as an indigenous source of energy that is both renewable and environmentally benign.

It is estimated that there are as many as forty to fifty small wind machines already installed and operating in Massachusetts, and the number appears to be growing steadily. Although these machines are not subject to much formal state or federal regulation, they generally do require approval by the local building inspector pursuant to both the State Building Code and the local zoning code. Problems can and often do arise either because the proposed wind installation exceeds maximum height or minimum setback requirements or because wind machines are not considered to be a permitted or accessory use in that locality.

Many applications for wind machines have been denied for one or more of these reasons. The mere fact that the zoning code lacks any provisions pertaining to wind machines has prevented some local building inspectors and boards of appeal from allowing them at all, and the variance has proved to be an inappropriate mechanism for solving the problem. Indeed, local zoning codes appear to be the major barrier, outside of economic and financial constraints, to more extensive development of wind energy in Massachusetts. Amendments to local bylaws and ordinances will be necessary in most cases if wind energy is to become a viable alternative.

A number of communities in Massachusetts have already taken steps to alleviate the problem of wind zoning. Edgartown and Oak Bluffs have

amended their bylaws to allow wind machines by special permit. The towns of Truro, Falmouth, and Andover considered proposed amendments at their Spring 1981 town meetings. Barnstable and Marshfield resolved the issue through reinterpreting their zoning codes to allow wind machines as an accessory use. Several other municipalities including Rockport, Orleans, Ludlow and Gardner are currently in the process of drafting changes to their zoning codes and still others have expressed an interest in following their lead. The efforts of these communities demonstrate the broad range of possible approaches to the wind zoning issue to take care of both individual and community needs.

This handbook is designed to assist municipal officials in all areas of Massachusetts with the task of resolving the wind zoning question. It is intended first to provide some basic information about wind machines, including their operating characteristics, siting requirements, types of installations and uses, and secondly to suggest different approaches to zoning for wind machines. The discussion will focus primarily on residential applications of wind energy since that is the area where the strongest interest has been shown to date. Where the issues appear to be significantly different, however, special attention is paid to commercial and large scale wind applications as well.

II. WIND MACHINES: TECHNOLOGY, USES AND SITING REQUIREMENTS

A. Wind Technology

Although wind has been used as a source of energy for hundreds of years, the technology has changed considerably during that time. The machines in use today do not resemble the historic windmills of Holland or of colonial times. Modern wind machines, or to use the proper terminology, wind energy conversion systems (WECS) more closely resemble an airplane propeller mounted on a tower. There are two general classifications of modern WECS: (1) horizontal axis, which means that the blades rotate on an

A. Wind Technology (continued)

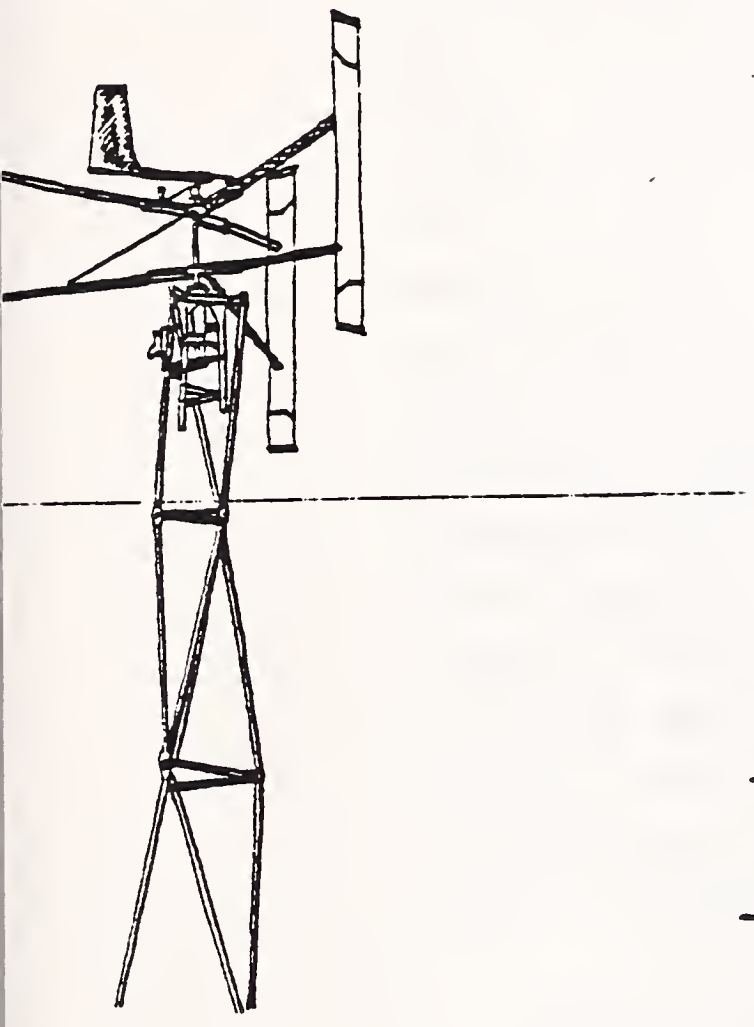
axis parallel to the ground, and (2) verticle axis where the blades rotate on an axis perpendicular to the earth. Most WECS rotors consist of two or three blades which may be made of steel, wood or fiberglass. The rotor is connected to a generator and both are usually mounted on a pole-type tower anchored with guy wires or a lattice-type, steel truss tower. (Figure 1 illustrates some of the more common types of WECS.)

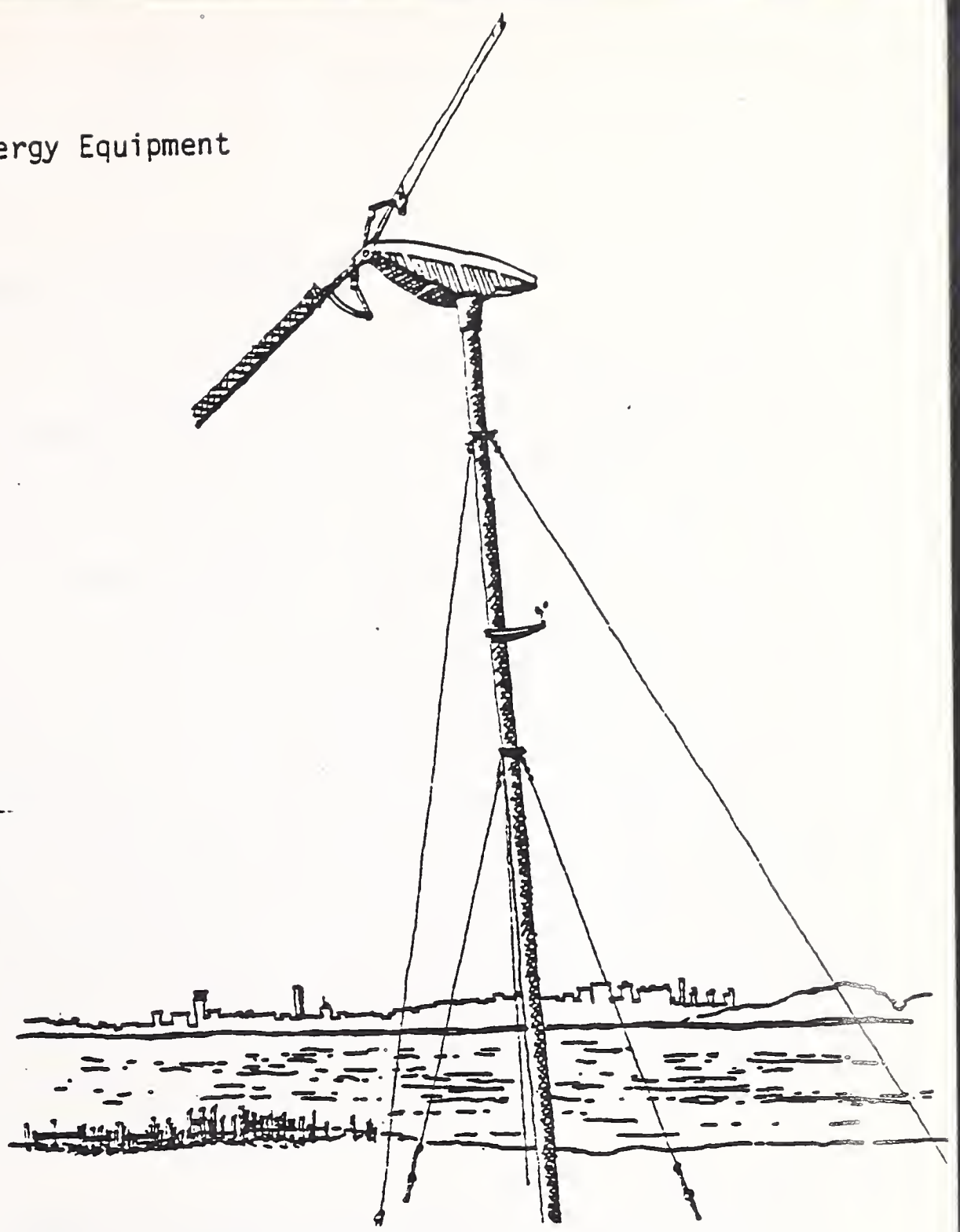
B. Uses and Applications of Wind Technology

Wind machines can be used to pump water or to produce other types of mechanical energy, but the most common use today is the production of electricity, either in the form of DC power to be stored in batteries or AC power to be fed directly into the house and/or the utility grid. (Under federal law owners of small power production facilities including WECS of less than 80 MW capacity can interconnect with the grid and sell excess power back to their local utility at rates to be determined by the state Department of Public Utilities.) This booklet will focus primarily on issues concerning residential size wind machines, which range from 2 to 10 kW in rated capacity. In terms of their physical size, these machines generally have a rotor diameter of 13 to 25 feet.[1] It is important to remember, however, that larger machines of 40 to 100 kW (with rotor diameters in the range of 40 to 80 feet) may be used for commercial applications such as an industrial plant or a town-owned facility. Utility companies are also considering sites for larger machines of 1,000 kW or more for centralized power production. Another type of commercial application is the so-called wind farm or series of WECS in an array. Finally, individual homeowners may consider pooling their resources to buy one large machine to produce power for several houses. All of these different types of installations and uses should be considered in developing a zoning scheme for wind machines.

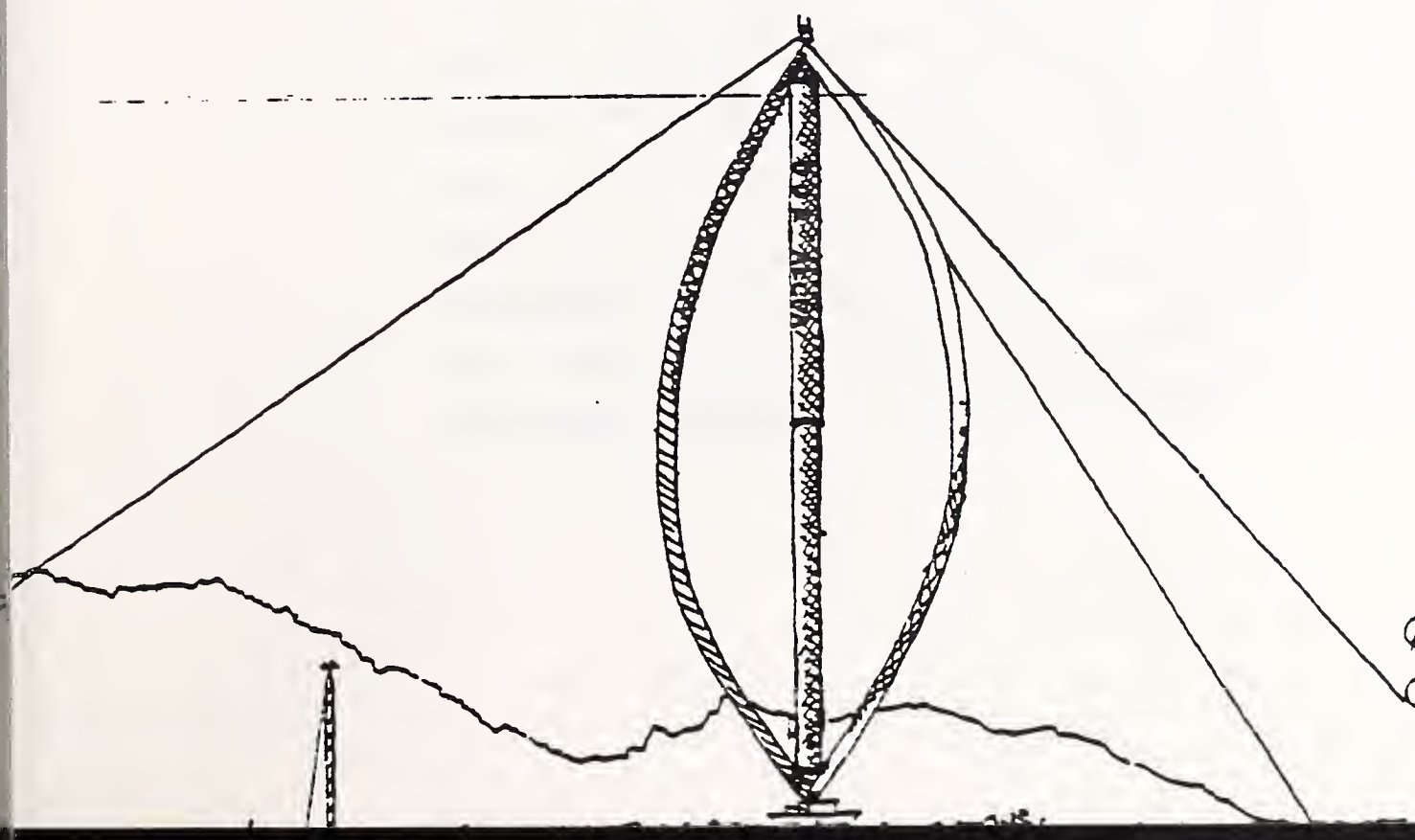
GURE 1 Examples of Common Wind Energy Equipment

clo-Turbine with Lattice Tower





Double-Bladed/Horizontal Axi
with Guy-Wire Tower



Ø-Darrieus with
Guy-Wire Tower

C. Siting Requirements for Wind Machines

In order to operate effectively, WECS must be installed in areas which are clear, open and have access to fairly high average wind speeds. Most WECS currently on the market are designed to operate at their rated capacity at wind speeds of over 20 mph, although they will begin to generate power at speeds of 7 to 10 mph. The amount of electricity generated by a WECS varies with the cube of the wind speed which means that a WECS which is designed to produce 2 kW (2,000 watts) at 22 mph will generate only 500 watts at 14 mph. (An average household using electricity for lighting and appliances consumes about 500 kWh per month which corresponds roughly to 2 to 4 kW of capacity. A household with electric heat uses approximately 1,200 to 1,400 kWh per month and would, therefore, need a WECS of 8 to 10 kW capacity.)[2] In short, given 1981 prices for electricity and wind technology, wind machines are likely to be economical only in areas near the ocean or in high elevations where the average wind speed is 12 mph or more.

In addition to being in an area with generally high wind speeds, the WECS must be sited so as to avoid turbulence caused by buildings, trees, and other solid structures. This means that the WECS should be placed on a tower that is at least 30 feet higher than any substantial structure within 100 feet. Thus, in congested or heavily wooded areas, the tower will probably have to be about 60 to 80 feet high. It is important to note that turbulence will not only reduce the efficiency and effectiveness of the WECS but will also increase the stress and cause potential safety problems such as the throwing of blades. Furthermore, the wind speed increases as the height of the tower increases. If the windspeed is 10 mph at eye level, it

c. Siting Requirements for Wind Machines

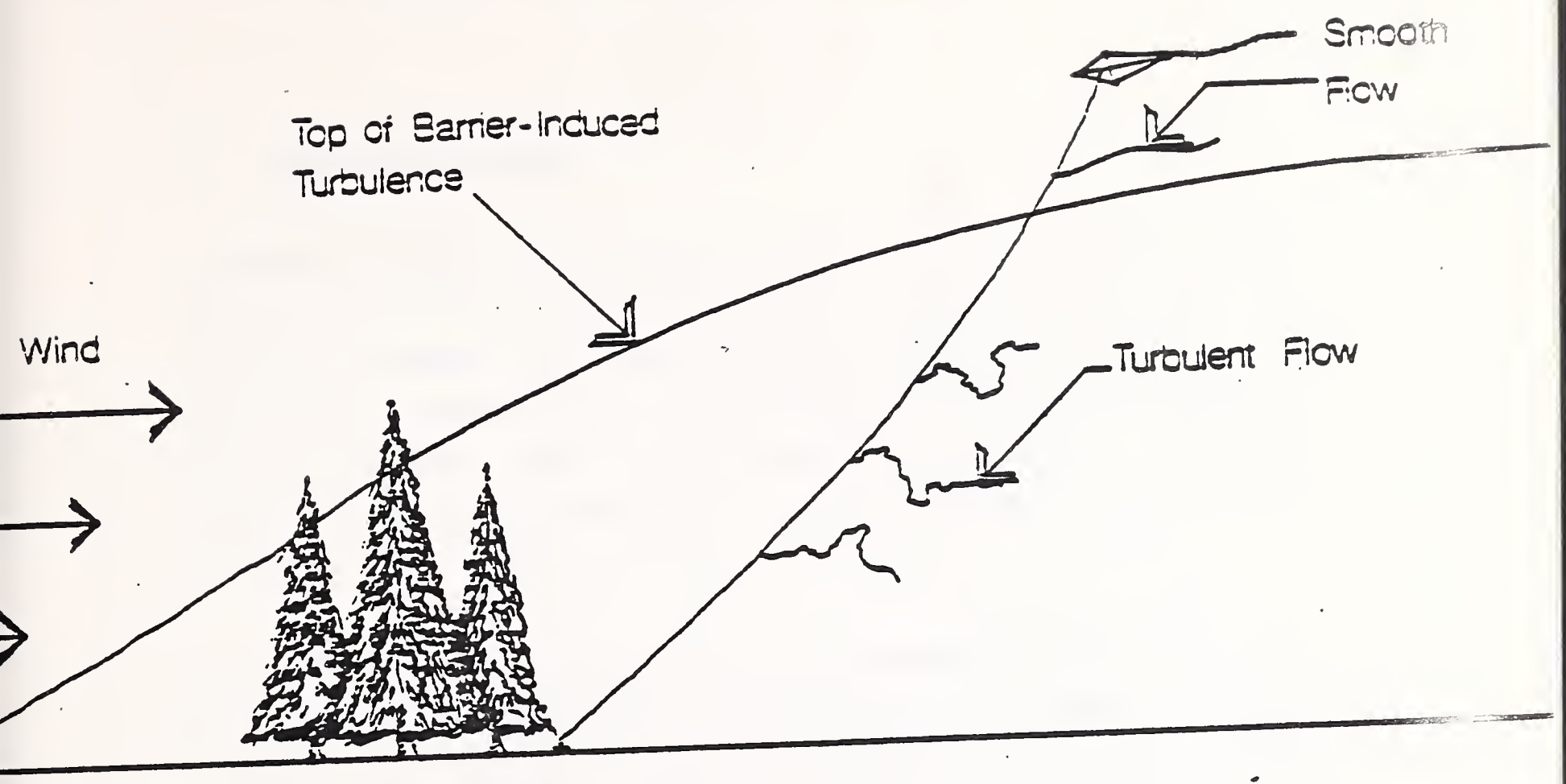
would be over 14 mph at 60 feet resulting in the WECS producing two to three times as much power.[3] An increase in height of 20 feet results in approximately 1 mph more annual average wind speed. It is, therefore, for economic as well as purely technical reasons that wind machines must be allowed to exceed normal height limitations. (Figure 2 illustrates the effects of siting and topography on wind turbulence and WECS output).

Although wind machines have relatively few impacts on the environment there are several issues such as safety, noise, television and radio interference and aesthetics which communities will want to evaluate in deciding when and where to allow WECS installations. These issues are discussed in detail below in the context first of regulation by existing state and federal government agencies and then in terms of designing amendments to local zoning bylaws or ordinances.

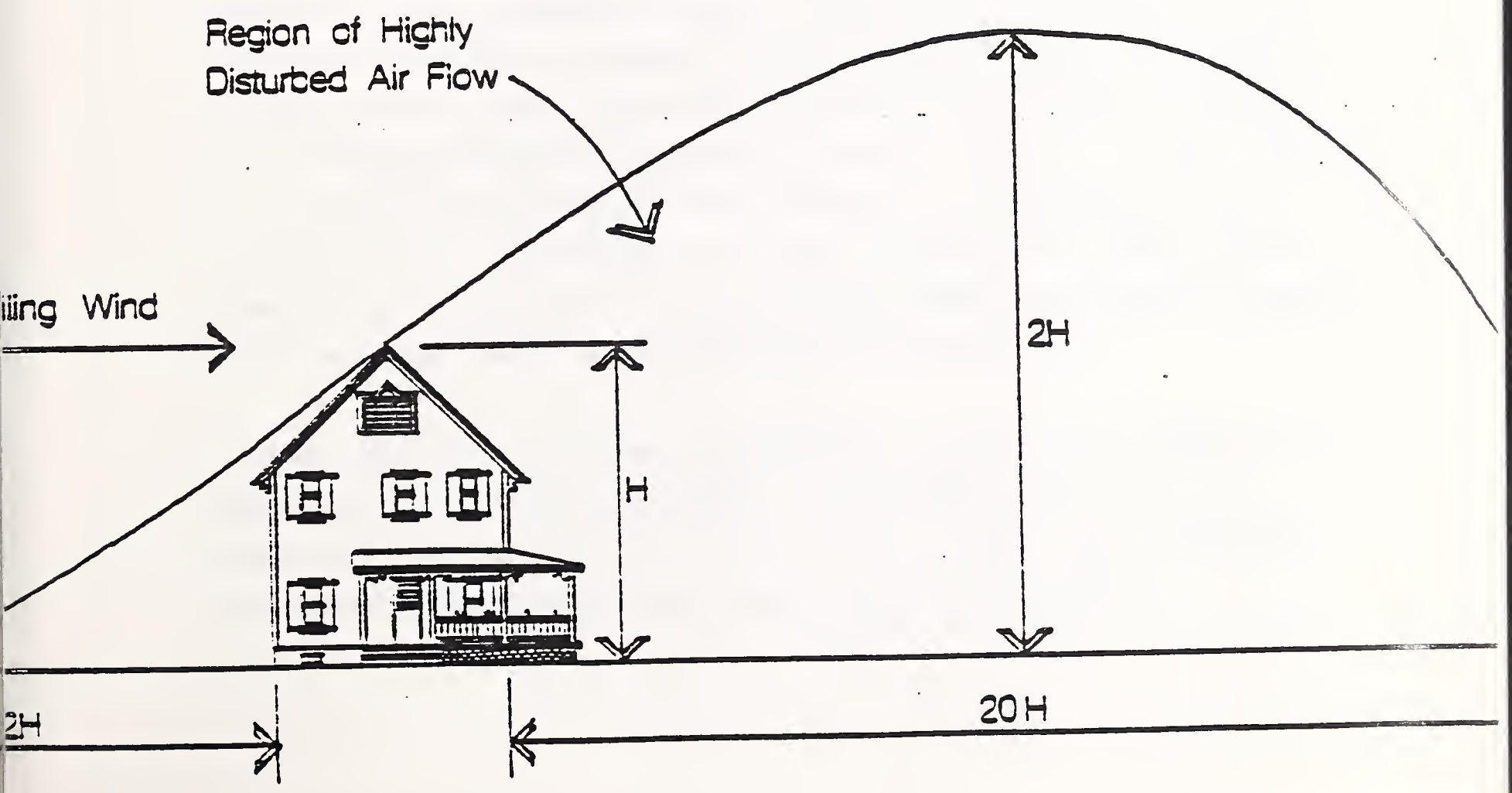
III. EXISTING GOVERNMENT REGULATION OF WIND MACHINES

There is no single agency at the federal or state level which regulates wind energy installations nor is there any special review procedure or permit that must be obtained for a commercial or residential WECS. There are a few government agencies, however, whose regulations may affect WECS installations in certain locations. Although these agencies (with the exception of the State Building Code which is administered by local building inspectors) will conduct their review independently of local zoning boards, municipal officials should be aware of their concerns as they affect the design of an appropriate local zoning scheme for wind machines. This section includes only a brief description of the relevant agencies and their concerns. Excerpts from their regulations are included in Appendix A.

FIGURE 2 Topographical Features



Simple Method of Detecting Turbulence



Region of Disturbed Air Flow Over a Small Building

A. State Building Code

In every instance, the prospective owner of a wind machine should apply for a building permit from the building official in his city or town. Although the State Building Code (780 CMR) does not specifically address engineering, design or construction standards for wind machines, existing provisions are adequate to protect the public and to protect commerce of the machines from capricious or arbitrary requirements by local officials.

Perhaps the closest relative to a wind machine for which there are explicit Code provisions is a radio or television tower. Section 426.0 discusses such issues as location and access, construction, loads, dead loads, uplift and grounding. In addition, it references Section 715.0 for wind loads and Section 925.0 for fire resistance ratings.

Taken jointly or severally, these sections would seem to offer sufficiently broad authority for the building official to be able to assure the safety of the public. As for the manufacturer, the installer or the prospective owner, if they were to be aggrieved by a building official who refused a building permit--despite adherence to these sections--they would have recourse to the Board of Appeals of the State Building Code Commission (Section 126.0). In fact, when all of the documentation has been completed, if a building official is uncertain of its validity or reluctant to act on the application, either party can petition the Building Code Commission Board of Appeals to review and act upon the application for the permit.

It should be pointed out that reliance upon the seal and signature of a registered professional engineer, as required by Section 113.7, should offer further assurance to the owner and the local community, since these professionals carry insurance for liability.[4]

B. Federal Aviation Administration and Massachusetts Aeronautics Commission

The Federal Aviation Administration (FAA) and the Massachusetts Aeronautics Commission are the agencies primarily concerned with the height of towers near airports. Their regulations are very specific and will require review of WECS installations that are located in certain zones around airport runways and landing strips. Under Chapter 90 Section 35B of the Massachusetts General Laws, (M.G.L.) a permit is required for any structure over a certain height that is to be built within an area extending 1,500 feet on either side and 3,000 feet beyond the end of a runway or landing strip. Thus, a WECS installed on a 100 foot tower would have to be at least 2,000 feet from the end of a runway or else a permit would be required. The FAA also requires notice of any structures to be built "near" an airport, heliport or official seaplane base. The definition of "near" is roughly within 20,000 feet of an airport having a runway of more than 3,200 feet or within 10,000 feet of an airport with shorter runways. Once again, the acceptable height limit of structures within this area is determined according to a ratio of tower height to distance from the runway.[5]

C. Local and State Historic Commissions

The Massachusetts Historical Commission has authority to review and comment on all projects that are subject to review under both the state and federal Environmental Policy Acts. In addition, local historic district commissions must review and approve changes to the buildings and surrounding landscape within local historic districts established pursuant to M.G.L. Chapter 40C. Both the state and local historic district commissions are concerned primarily with regulating the exterior features of all architecturally, historically, and culturally significant structures.[6] The State Historical

C. Local and State Historic Commissions (continued)

Commission is also concerned with impacts on archeological sites which may be important to consider in the site selection process.

The purpose of the local historic district commissions is to preserve the historic fabric and integrity of a defined area that has been designated as a historic district. They are concerned primarily with structures that are visible from a public way. Their review is conducted separately from that of the local zoning board of appeals, but their approval is required before a building permit can be issued for any new construction or modification of a structure within their district.[7]

Local district commissions can issue one of three types of certificates: appropriateness, non-applicability and hardship. For a certificate of hardship, the commission must find that denial of a permit would impose substantial hardship, financial or otherwise on the applicant and that the permit could be approved without substantial detriment to the public welfare or derogation of the purpose and intent of the local historic district. It is unlikely for reasons which will be discussed below in more detail, that the owner of a WECS could prove hardship. As a second alternative, the commission can grant a certificate of non-applicability if it determines that a project would not involve any change in exterior architectural features or for other reasons would not be subject to its review. Finally, the local district commission may issue a certificate of appropriateness if it finds that the WECS can be installed in such a way as to be compatible with the goals of the district. The certificate may include specific conditions such as a setback requirement to remove a structure from public view.

In theory, wind machines which are mounted on towers away from existing buildings should not be barred from historic districts because they represent "reversible changes" which need not

C. Local and State Historic Commissions (continued)

permanently alter the historic fabric of the district. In practice, however, WECS may be subject to some restriction by local historic district commissions to the extent that they represent an intrusion that is not consistent with the historic character of the area. Although historic district commissions are technically concerned only with preserving historic integrity, aesthetics will be a major consideration in their review process. Problems may arise in cases where WECS that are placed on very high towers become visible from a public way in a historic district because no setback requirement is likely to succeed in hiding them from view. It is not yet clear what approach local district commissions will adopt with regard to WECS installations or how serious the problems may be. The degree or scrutiny and the standards applied to WECS will depend to a large degree on the particular district and the character of the area involved.

D. Environmental Impact Review

The Massachusetts Environmental Protection Act (MEPA) establishes a procedure for comprehensive review of the environmental impacts of all projects which require a permit or financial assistance from a state agency.[8] Projects which involve leasing or use of state lands are also subject to MEPA review. Several agencies including the Massachusetts Historical Commission, the Department of Environmental Quality Engineering, Coastal Zone Management and the Division of Fisheries and Wildlife have the opportunity to review and comment upon all proposals through the MEPA process. Since most WECS installations will not require state permits or grants or the use of state land, however, they will not typically be subject to MEPA review. Nevertheless, local officials may find it helpful to consult with

D. Environmental Impact Review (continued)

officials in these various agencies on questions regarding environmental impacts.

Large WECS installations such as wind farms in the coastal zone might be subject to independent review by the Coastal Zone Management Office. Projects located in wetland areas would probably also require approval by the local conservation commission pursuant to the Wetlands Act (M.G.L. Chapter 131 Section 40). At this point, state officials do not foresee any significant environmental impacts related to residential WECS installations other than the issues of noise, electromagnetic interference and safety which would normally be addressed in the context of zoning. Such impacts may occur to a greater degree in the case of windfarms or other large commercial applications which may also involve clearing of large land areas. Even those impacts do not appear very serious, however. Tests conducted by the federal government on large scale machines showed that both birds and insects were able to avoid harm from the blades and the local wildlife habitats remained relatively undisturbed.[9]

IV. PROCEDURAL OPTIONS FOR ZONING OF WIND MACHINES

An individual proposing to install a wind machine for residential or commercial use today is likely to encounter problems with the zoning code either because of height or setback requirements or because wind machines are not considered permitted uses in that locality. The need to zone for wind machines and the specific form of zoning ordinance adopted will vary among cities and towns due to differences in existing zoning laws and the attitude of each community toward wind machines.

This section attempts to outline the various procedural options for zoning wind machines that either exist now or could be developed

IV. PROCEDURAL OPTIONS FOR ZONING OF WIND MACHINES (continued)

through minor amendments to the bylaws. There are advantages and disadvantages to each approach and it is up to each individual community to decide which method is most appropriate. The three basic options which exist are Variances, Accessory Use, and Special Permits.

A. Variances

In general, a variance is an authorization to use land, buildings, or structures in a manner that is otherwise prohibited by a zoning ordinance or bylaw. The variance is designed to be an escape hatch when the literal terms of a zoning ordinance or bylaw unnecessarily cause hardship. A variance accommodates individual cases that are unique under statutory standards and is intended to prevent confiscation of property without payment by permitting a person to make beneficial use of his land, building or structure.[10] The same standards for review apply to both use and dimensional variances.

M.G.L. Chapter 40A Section 10 requires that the zoning board of appeals find that there are circumstances relating to the soil conditions, shape or topography which especially affect the land or structure in question but which do not affect generally the zoning district in which the land or structure is located. The board must also find that due to the above mentioned circumstances, a literal enforcement of the provisions of the zoning ordinance or bylaw would involve substantial hardship, financial or otherwise to the petitioner or appellant for a variance.[11]

These conditions for the granting of a variance will be extremely difficult for the owner of a wind machine to satisfy. In applying for a variance from the maximum height requirement, it is unlikely that the WECS owner can substantiate to a zoning board of appeals that there are special circumstances concerning the

A. Variances (continued)

soil conditions, shape or topography of the land or structures on his particular parcel which do not affect other land parcels in the same district. Wind machines must be placed on relatively high towers no matter where they are located in order to gain free access to high average winds and avoid the turbulence created by nearby trees, buildings, and other structures. Depending on the topography and average wind speed of a particular site, the WECS tower may need to be anywhere from 40 to 100 feet high, but in any case, it will probably exceed the standard height limitation set forth in most ordinances or bylaws.

In addition, it will be extremely difficult if not impossible for a WECS owner to show substantial hardship due to literal enforcement of the zoning bylaw or ordinance. While those who favor development of alternative energy sources may feel that it is a hardship to be deprived of the right to install a wind machine, such considerations are not applicable to the granting of a variance. The courts have already stated that personal health and family circumstances are not hardships affecting the land and that there is no substantial hardship merely because there may be expenses involved in continuing an existing use.[12] Thus, the burden of higher electrical bills and the public or private benefits of generating energy from the wind are not relevant factors in determining hardship for zoning purposes. Finally, regardless of the community's views on such issues as safety, noise, or aesthetics related to wind machines, it would be difficult for the zoning board of appeals to find that deviation from existing height restrictions would not derogate from the purpose of the existing bylaw or ordinance.[13]

In sum, the variance appears to be an impractical and unworkable alternative for owners of wind machines. Indeed, at least seven applications for variances by WECS owners already have been denied

A. Variances (continued)

by local zoning boards in Massachusetts during the past year.[14] Towns and cities will have to consider other zoning options if they wish to allow WECS.

B. Accessory Use

Another option available under most existing zoning schemes would be to define wind machines as an accessory use "customarily incidental" to a residential or commercial use, thereby permitting them as a matter of right. This is the alternative which has been adopted by the town of Barnstable.[15] It is certainly logical to suggest that wind machines are accessory to a residential or commercial use since electricity is a very necessary feature in most buildings. Still the issue of whether or not WECS are "customary" is open to debate, depending on one's definition of the term. WECS are not yet prevalent in most communities, but they may become so in the very near future. In addition, windmills were common in many areas of Massachusetts one hundred or more years ago.

Leaving the definitional issue aside, however, it is important to note that in order to be effective such a modification or interpretation of the zoning ordinance or bylaw would have to be combined with an exemption from or lessening of the existing height restrictions. Unless specifically exempted, accessory uses are subject to the dimensional requirements of the bylaw or ordinance. Thus, if an exemption is not granted, the WECS owner would still have to apply for a dimensional variance which would be subject to all the difficulties discussed above. If an exemption were included, WECS could be permitted as a matter of right. This option would probably be the most favorable to WECS owners and to the wind industry. It would limit the review process for WECS but would allow local officials to maintain control over matters of siting and safety of WECS installations.

C. Special Permits

The State Zoning Act established special permits as a mechanism for allowing specific types of uses in certain districts on the basis of case-by-case review. Special permits may be issued only for uses which are in harmony with the general purpose and intent of the zoning ordinance or bylaw. General standards for granting a special permit must be set forth in the bylaw, but individual permits may also impose conditions, safeguards and limitations on time or use.[16] The standards or conditions can thus be tailored to the particular use that is to be allowed by special permit. It is a far more flexible mechanism than the variance because it involves case-by-case review of applications, yet it would enable the community to exercise more control than under the accessory use option. Special permit applications must be reviewed at a public hearing to be held within 65 days of the filing date. A decision by the special permit granting authority is then issued within 90 days from the date of the hearing. Although the special permit granting authority could certainly act within a shorter period of time, under a worst case scenario, the process of obtaining a special permit could be time consuming and costly to the WECS owner.

An amendment to the zoning bylaws or ordinances which allowed WECS by special permit could be very general in nature or it could specify in detail the conditions for the issuance of a permit. Bylaws adopted or proposed by the towns of Oak Bluffs, Edgartown, Lower Township, New Jersey, and Guilford, Connecticut for example, establish certain criteria regarding height, setback, safety and noise which must be met before a special permit for a WECS installation is granted. Thus, if the community can agree on a set of minimum standards or conditions under which wind machines would be acceptable, this approach could be very effective. It is important to note, however, that these standards or criteria for special permits can be very restrictive. Anyone proposing a WECS installation which exceeded the standards for height or setback set forth in the bylaw for special permits

C. Special Permits (continued)

would have to apply for a variance unless the bylaw gave power to the special permit granting authority to set the conditions. In determining which approach to follow, therefore, municipalities should consider carefully any restrictions to be imposed and should try to design their zoning bylaws to allow for flexibility.

V. PROVIDING FOR WIND MACHINES IN THE ZONING BYLAW OR ORDINANCE

Under most existing zoning schemes, if no changes are made to specifically permit the use of wind energy then WECS owners will have to apply for dimensional and/or use variances and encounter all the difficulties discussed above. If a city or town wishes to allow WECS as an accessory use then the bylaws or ordinances must be amended to include WECS in the definition of accessory uses and to either exempt them from existing height restrictions or establish a new height limit for WECS. As an accessory use, WECS could be allowed automatically in all residential or commercial districts, or the bylaws could specify particular zones for WECS. Finally, if the municipality elects the special permit option, then a permitting procedure must be established, a special permit granting authority designated and the criteria or standards set forth by which permits for WECS will be granted. In going through these steps, there are several major issues which should be addressed. The following section will discuss the issues in detail and suggest some different approaches to handling them in the zoning code.

A. Safety

Any new technology is bound to raise questions of safety and reliability. Since the major purpose of local zoning is to protect the health, safety, and welfare of individuals within the community, it is certainly appropriate to address the safety of WECS installations in the local bylaws or ordinances. There are obvious concerns

A. Safety (continued)

regarding the stability of the tower, the likelihood of its collapse and the probability that a blade will fly off the machine or that ice will be thrown off in severe winter conditions. In addition, there may be concern over access to the tower and the possibility that children or other trespassers will climb it and injure themselves.

Many of these concerns may be adequately addressed outside of the zoning code through reliance on manufacturer's certification, homeowner's liability insurance and the requirements of the State Building Code. Most commercially available WECS have been tested by the manufacturers and/or the federal government through its program at Rocky Flats, Colorado under fairly extreme wind and weather conditions. Manufacturers also calculate the degree of stress or wind loading that their machines and towers can withstand and they can certify their units to that extent. Most WECS units are designed with a feathering and braking system so that they will shut down in winds in excess of 35 to 40 mph to help avoid the risk of blade throw and other hazards. Furthermore, it is in the best interest of both the manufacturers and the WECS consumer to avoid potential problems through safe design and careful maintenance and to protect themselves with liability insurance as well. Finally, the State Building Code would require approval of a registered engineer for the design and installation of all types of towers.[17] Such professionals also carry liability insurance for their inspection and certification work.

Safety issues such as the potential for blade and ice throw or tower collapse may be addressed through a setback requirement which is discussed below. Alternatively, the municipality could elect to rely on the Building Code requirements and the manufacturer's certification of WECS reliability. Engineering design specifications and test data could be required as documentation from the manufacturer along with certification by an engineer registered in Massachusetts. Reference can also be made to the Performance Reports and Failure Analyses that

A. Safety (continued)

are published regularly by Rocky Flats on all the machines included in their testing program.[18] Access to the tower can be easily limited by either installing a 6 to 10 foot fence around the base of the tower, installing anti-climb shrouds over the bottom portion of the tower or merely removing the tower climbing apparatus to 10 or 12 feet above the ground.[19] The local building inspector can review the manufacturer's plans and drawings and can supervise the actual WECS installation to insure that it meets all Building Code requirements. Regular inspections by local building code officials or the manufacturer's or dealer's own maintenance schedule could be relied upon to ensure the machine was kept in safe condition.

In considering these options it is important for communities to understand that the wind industry is still very young. There is a shortage of reliable, long-term test data and many questions concerning safety cannot be answered with any degree of certainty. If the safety requirements are too stringent in the local zoning laws, then the cost of compliance may become prohibitive and the wind industry will be severely crippled.

B. Setback

Setback requirements are primarily related to the safety questions although they may be designed for aesthetic reasons as well as to protect the interests of neighboring property owners. Setback requirements for WECS could be omitted from the zoning bylaws completely or decided on a case-by-case basis through the special permitting process. If a minimum setback is to be specified in the bylaws or ordinances, however, there are various ways to calculate it.

The zoning law could specify that all WECS be installed at least one tower height or one tower height plus one rotor radius away from the nearest property line. This is a typical setback requirement that

B. Setback (continued)

has been used ostensibly to protect neighbors from property damage in the event of tower collapse. The actual probability of a WECS tower collapsing is very low, however, since the design and construction of towers is well developed and has been tested over a fairly long period of time. Wind machines are generally mounted on standard towers that have been used in the past for other purposes. Once again, these towers are subject to certain design requirements of the State Building Code. Many engineers have pointed out that even in the unlikely event of a tower failure, the tower would probably collapse directly downward rather than pivoting from its base.[20] Thus, the area which could potentially be damaged would be less than a tower height away.

Because wind machines must be placed on fairly tall towers (ranging from 40 to 100 feet and sometimes higher) in order to function effectively, a setback requirement of one tower height away from the property line is quite stringent and will limit WECS installations to fairly large residential and commercial lots. Such a requirement also fails to provide for the situation where several homeowners wish to share a large machine which might be installed on or very near their joint property line. As an alternative, if the community is primarily concerned with potential damage to people and buildings, the zoning law could specify a setback requirement of one tower height away from neighboring houses, commercial buildings and other structures occupied or used by people. This would allow WECS installations on smaller lots but would not address the issue of potential property damage.

A setback requirement that is tied to the probability of blade or ice throw would be the most stringent. Because of the variation in design and construction of WECS it is extremely difficult to calculate a generic blade throw probability analysis that would be at all reliable.

B. Setback (continued)

Turbulence created by the topography of a particular site, the point at which a blade is disconnected from the rotor, the way in which it is flung through the air, and the force and direction of the wind blowing at the time are just some of the variables which will affect how far a blade will travel and how much damage it can do.[21] Rough calculations made by the Northeast Solar Energy Center (NESEC) in 1979 for the town of Hanover, New Hampshire concluded that to be absolutely safe from the risk of blade throw, a machine on a tower less than 80 feet high would have to be set back anywhere from 100 to 400 feet depending on the rotor radius.[22] It is estimated that ice can be thrown for distances up to five times the rotor radius of a WECS, but ice should not build up on a machine that is maintained and operated properly. Once again, however, it is important to remember that these figures represent very rough calculations which will vary considerably according to the type of equipment, materials and control devices used in the WECS as well as the local weather conditions and the degree of maintenance of a particular machine. Reliance on any of these figures for determining setback requirements is thus questionable at best and would certainly be a severe hindrance to the development and use of wind energy devices in many areas of the Commonwealth.

Once again, in determining which of these various setback requirements is most appropriate, some form of balancing test is called for. If a community is extremely safety conscious and wants to establish a strict setback requirement such as one tower height or more from the property line, then WECS installations will be limited to large lots of more than one acre. An alternative would be to specify the strict setback limit in the bylaws as a condition for the granting of permits for WECS on smaller lots. Conditions for granting WECS permits on smaller lots could include documentation and proof of a good safety record for the machine and liability insurance held by the manufacturer

B. Setback (continued)

and/or the WECS owner sufficient to cover personal and property damage. In imposing any of these conditions, however, the community must bear in mind that long term test data and safety records do not exist for many WECS units at this time. If the community is to allow the use of wind energy anywhere beside the most rural areas, then some of the risks associated with the new technology may have to be assumed.

C. Tower Height

Limitations on the height of WECS are particular concern for reasons which have already been discussed. Wind machines must be placed at least 30 feet above any buildings, trees, or other structures that are within 100 yards in order to avoid turbulence and to function effectively. In addition, if the proposed installation is in a low-lying or inland area where the average wind speed is not very high, then the owner may wish to place the unit on a bigger tower to gain access to higher wind speeds. For residential applications the height of WECS towers will range from 40 to 100 feet with the typical height being 60 to 80 feet. Even taller towers may be required in certain situations, however.

It has also been pointed out that tower height may be a function of the setback requirement (or vice versa) which is in turn related to the safety issues. If a setback of one tower height away from the property line is established, that will obviously limit the size of acceptable WECS installations and will tie height considerations to the size of the particular lot.

The procedural alternatives for height requirements are very similar to those mentioned for setback. To allow the most flexibility to WECS owners and manufacturers, the community could exempt WECS from existing height requirements entirely. This might be appropriate if WECS are to be reviewed on a case-by-case basis for a special permit

C. Tower Height (continued)

anyway or if the setback requirement by its nature already limits the height. Similar exemptions are allowed in many zoning codes for ham radio antennas, flag poles and other tall structures. In rural areas where residential and commerical lots are very large anyway, height may not even be an issue.

If the community wants to set some type of height limit for safety or aesthetic reasons and can agree on what that limit should be, then the zoning bylaws could specify that all WECS installed within that height limitation would be permitted as a matter of right and defined as an accessory use. The bylaws or ordinances could also provide a special permitting procedure for all WECS installations which would exceed the given height restriction. This option assumes that under Section 9 of the Zoning Act, special permits may be issued for a dimensional change as opposed to a particular use--a matter which is open to some debate.[23] Finally, the municipality could decide not to put any specific height restriction in the bylaws and instead to give the special permit granting authority the power to determine an acceptable height limit for each individual WECS installation based on factors such as the safety of the machine and the proposed setback distance from property lines or other buildings.

D. Noise

Noise is a typical concern to those who are unfamiliar with WECS and it is likely to be raised as an issue whether or not a noise provision is included in the zoning bylaws or ordinances. The amount of noise that a wind machine creates is a function of wind speed and of size, design, and the materials used in its construction. Large machines and certain types of rotors may create excessive noise under certain conditions. It is fairly safe to assume, however, that most WECS installed for residential use will not create a noise problem. The situation with commercial WECS may vary according to the exact size and type of machine that is proposed.

D. Noise (continued)

Once again, the community may decide to adopt one of several approaches to the noise question. The local zoning bylaw could specify the maximum allowable decibel (dBA) level for all WECS installations. That level could be determined on the basis of tests conducted by the government at Rocky Flats which have shown residential size WECS to produce sound in the range of 40 to 60 dBA, or it could be keyed to other types of common sounds measured on a standard dBA scale. For example, charts developed by the Environmental Protection Agency to measure decibel levels show that traffic noise in urban areas is generally 80 to 90 dBA whereas office noise, including typewriters and normal speaking voices are in the range of 50 to 60 dBA. The sound of the wind alone can often be in excess of 50 dBA. Assuming that people could agree on how or where to place WECS on such a chart, the question remains as to where one should measure decibel levels from--the property line, the nearest street or a neighbor's house?

Another approach would be to require the manufacturer to supply test data or decibel level measurements for its particular machine and to allow the zoning board of appeals or other special permit granting authority to determine whether that level is acceptable. Or, the bylaws could merely state that all WECS installations shall not exceed the ambient noise levels of the particular neighborhood or zoning district. Under any of these approaches, if a noise problem developed after the WECS was installed, neighbors could call on the local building inspector to enforce the zoning bylaw pursuant to Section 7 of the Zoning Act. Even if the community decides to omit any mention of the noise issue from the zoning code, the neighbors would still have a method for redress of their grievances through the established procedures for dealing with public nuisances. At the initial stage of review it should be the responsibility of the WECS manufacturer to show that his machine does not normally produce excessive noise, but once the WECS is approved and installed the burden of proof should rest with the complaining party.

E. Electromagnetic Interference (EMI)

The situation with respect to electro-magnetic or television (TV) and radio interference is very similar to the question of noise. Tests have not been done for all commerically available WECS but once again, interference with TV and radio signals has not proved to be a problem with most residential size machines. There is no effect at all on cable television. EMI is largely a function of size and type of material used in construction of the WECS. Research on the effects of small wind machines on TV and radio reception is currently being conducted at the University of Michigan. Although the final report is not yet published, preliminary results indicate that residential size machines (less then 10 kW) may cause interference for distances up to 40 feet at the highest UHF TV channel frequency.[25] If the rotor blades are made of wood or fiberglass instead of steel, the range may be reduced to 16 to 20 feet. Horizontal axis machines may create slightly more interference than vertical axis WECS and multiple blades may also increase interference. The best way to reduce interference is to avoid installing the WECS in the line of transmission from the TV station to the individual's house. One other important point that researchers note is that no one knows what additional effects if any will be caused by an array or large number of wind machines in close proximity.[26] For this reason, communities may want to require closer scrutiny of commercial wind farms or groups of residential machines.

To protect against electro-magnetic interference, the community may request test data or other forms of proof from the manufacturer that its machine will not cause interference. Alternatively, the zoning bylaw or ordinance could require that any WECS installation satisfy the standards set forth by the Federal Communications Commission in its regulations (47 C.F.R. Part 15).[27] The advantage to including a reference to the FCC regulations in the zoning bylaw is that the local enforcement power under M.G.L. Chapter 40A Section 7 could then be used to correct any problems that may arise. It is worth

E. Electromagnetic Interference (EMI)

noting, however, that here as in the case of noise discussed above, problems created by the WECS will be experienced most acutely by the WECS owner since the unit is likely to be closest to his or her house. There is thus a built-in incentive for the WECS owner first to make certain that the unit he or she buys does not normally create TV interference or noise and, secondly to correct any problems that do arise immediately.

F. Aesthetics

The issue of aesthetics is a very difficult one to deal with in zoning laws generally and with regard to wind machines in particular. The obvious reason for the difficulty is the extremely subjective nature of the issue. A WECS tower which may look ugly to some will appear as an aesthetically pleasing form of alternative energy to others. If the sentiment of the community is strongly against wind machines then the only solution short of precluding all WECS installations (which could raise other legal or constitutional issues) may be to require fairly stringent setback or height requirements. The aesthetic issue may resolve itself over time as people get more accustomed to the presence of wind machines. If so, then silence may be the best policy with respect to the zoning code. At the very least it seems that the aesthetic issue should be balanced against the energy value and general public benefit that wind machines provide.

G. Use and Performance

Once a city or town decides that wind machines should be allowed at least in some areas of the community and under certain conditions, the question of use should largely disappear. With the exception of very large (over 100 kW) machines or wind farms which will probably

G. Use and Performance (continued)

be owned by utility companies or small power production companies for the production and sale of large blocks of power, the typical WECS will be installed primarily for use on site in a commercial or residential building.

Uner a provision of federal law known as the Public Utility Regulatory Policies Act of 1978 owners of wind machines and other alternative electricity producing devices are allowed to sell power back to their utility at a rate equal to the utility's avoided cost. This offers them an option for disposing of excess power which is much cheaper than battery storage. It is not the same as selling retail to other customers or otherwise operating as a commercial entity, however. Thus, WECS for residential use or for use by a local business should be considered as incidental to the primary use and not as a separate commercial operation. The problem of abandonment of the WECS could be addressed specifically in the zoning code such as by stipulating that the machine be removed if abandoned for a certain period of time, or it could be omitted and handled through the existing local nuisance procedures.

Similarly, the issue of WECS performance is probably one that can remain outside the zoning code except to the extent that it relates to safety as discussed above. Questions regarding how much power the wind machine will produce at given wind speeds and the related issue of whether or not the installation represents a sound investment in alternative energy primarily concern consumer protection and should probably be left to the individual and the WECS manufacturer or dealer to resolve. Information on such topics is available to all individuals and local officials from both state and federal energy agencies as well as the Northeast Solar Energy Center.

H. Commercial WECS Applications

Although most of the discussion so far has focused on zoning for residential WECS since those applications are most common, the issues surrounding WECS for commercial use should be essentially the same. The only major difference will be that large scale commercial WECS installations will probably require more land area and free air space and may create more significant safety, noise, TV interference, and aesthetic problems. Once again, the differences will depend on the technology involved. A local business proposing to install a WECS to produce electricity for its own industrial plant or office building in a commercial district should be able to follow the same review process as the owner of a residential WECS. If a special permit is required, then the special permit granting authority can impose additional conditions or else require more complete proof from the WECS manufacturer or owner to allay any fears regarding safety, noise, and other issues discussed above. It is possible that very large scale applications of WECS by utility companies and wind farm proposals will require a higher degree of scrutiny and perhaps a different level of review. Regardless of what procedures are adopted for zoning residential and small scale commercial WECS for on-site use, some form of special permit review should be designed for these large scale commercial applications.

VI. CONCLUSION

There undoubtedly are other issues which may arise concerning the installation or operation of wind machines in a given community. If enough flexibility is incorporated into the design of wind zoning procedures, then these issues can be dealt with on a case-bycase basis. Allowing WECS by special permit subject to some of the standards and requirements discussed above is likely to provide the mixture of flexibility and control that will be appropriate for most Massachusetts communities.

ENDNOTES

[1]The Enertech 1500 which is a horizontal axis machine with a capacity of 1.5 kW has a rotor diameter of 13 feet. The Pinson Cycloturbine, another residential size machine of 5 kW has vertical blades of 12 feet in height with a rotor diameter of 16 feet. 10 kW WECS typically have a rotor diameter of 25 feet.

[2]Executive Office of Energy Resources calculations based on conversations with local utilities.

[3]Enertech Corporation, Planning A Wind Powered Generating System (Norwich, Vermont: Enertech Corporation, 1977), p. 15.

[4]Report by Robert Sheridan, State Building Code Commission, April, 1981.

[5]Federal Aviation Administration Advisory Circular, see Appendix A.

[6]Establishing Local Historic Districts, 2nd rev. ed., Patricia Weslowski (Boston: Secretary of the Commonwealth, Massachusetts Historical Commission, 1978), p. 2.

[7]Historic Districts Act, M.G.L. Chapter 40C Section 6.

[8]Massachusetts Environmental Policy Act, M.G.L. Chapter 30 Sections 61-62H.

[9]Proceeding of the Third Wind Energy Workshop, p. 403 as cited in Massachusetts Energy Office, Wind Report, October 1978, p. 68.

[10]Letter from Donald J. Schmidt, Land Use Specialist, Executive Office of Communities and Development, April 3, 1981.

[11]Ibid.

[12]Winn v. Board of Appeals, Saugus, 358 Mass. 797 (1970). City Council of Waltham v. Vinciullo, 364 Mass. 624 (1974).

[13]Op. Cit, letter from Donald J. Schmidt.

[14]Variances for residential WECS have been denied by zoning boards of appeal in Andover, Falmouth, Rockport, Sandwich, Weymouth, Wellfleet and Weston. This list is by no means complete; it represents only those cases of which the Executive Office of Energy Resources was aware at the time this handbook was written.

[15]Bruce P. Gilmore and Robert D. Smith, Memorandum to Planning Board of the town of Barnstable re. Regulation of Windmills, November 12, 1980.

[16]M.G.L. Chapter 40A Section 9.

[17]780 CMR, State Building Code, Section 113.7.

[18]These reports are prepared by the DOE Rocky Flats Wind Systems Program and are available upon request from the Wind Energy Systems Group, P.O. Box 464, Golden, CO 80401.

[19]C. Lawless-Butterfield, "Small Wind Energy Conversion Systems: Zoning Issues and Approaches", Rocky Flats Wind Systems Program Draft Technical Memorandum (DOE Contract No. DE-AC04-76DP03533, March, 1981) pp. 14-15.

[20]Paul Wendelglass, Memorandum to Interested Parties re. "Zoning for Wind Systems", New York State Energy Office, September 19, 1980, p. 2.

[21]Op. cit., Lawless-Butterfield, p. 16.

[22]Northeast Solar Energy Center, "Proposed Amendments to the Master Plan and Zoning Ordinance of the Town of Hanover, New Hampshire to Allow Wind Energy Conversion Systems as a Permitted Use with Analysis and Supported Technical Documentation, " 1979.

[23]Section 9 of the Zoning Act states only that zoning bylaws or ordinances "shall provide for specific types of uses" by special permit, and it is unclear whether special permits can be used to allow a structure to exceed the dimensional requirements of the local zoning code. An amendment to the Act to clarify this point is under consideration.

[24]A. C. Hansen, "Community Impact of SWECS Noise" Rockwell International Rocky Flats Wind Systems Test Center Draft Report, April 1980, p. 1.

[25]Conversation with D. L. Sengupta, Research Scientist, University of Michigan Radiation Laboratory, re. preliminary findings to be published in "Study of Television Interference by Small Wind Turbines, "D. L. Sengupta, T.B.A. Senior and J. E. Ferris, (University of Michigan Radiation Laboratory Report No. 018291-3-T, May 1981).

[26]Ibid.

[27]WECS would be likely to fall within the definition of "incidental radiation devices" under the FCC regulations. See Appendix A for specific provisions.

[28]Public Law 95-617. Actual rates will be determined by the Massachusetts Department of Public Utilities. Regulations published in August, 1981 would permit owners of WECS with less than 30 kW of capacity to reverse their meters and obtain a credit on their electric bills.

ADDITIONAL SOURCES *

BOOKS

Eldridge, Frank. Wind Machines. 2nd ed. New York: Van Nostrand Reinhold, 1979. 1st ed. National Science Center NSF-RA-N-75-051, October, 1975. Available from U.S. Government Printing Office.

An excellent introduction to wind energy. It includes a review of the history of wind technology as well as descriptions, photographs and drawings of the various types of machines currently available.

Executive Office of Energy Resources. Free as the Wind. Summer, 1981.

Provides a general introduction to wind energy for residential use in Massachusetts. Booklet is aimed at the homeowner.

Park, Jack and Dick Schwind. Wind Power for Farms, Homes and Small Industry. U. S. Department of Energy. NTIS No. RFP-2841/1270/78/4, September 1978.

Provides very good coverage of all aspects of small wind systems applications.

Pickering, K. E., et. al. Wind Energy Resource Atlas: Volume 4-The Northeast Region. Battelle Pacific Northwest Laboratory No. PNL-3195 WERA-4 September, 1980.

Provides an overview of wind resources in the northeast based on data from existing monitoring stations.

Wegley, Harry L, et. al. A Siting Handbook for Small Wind Energy Conversion Systems. Battelle Pacific Northwest Laboratory No. PNL-2521 REV-1, 1980.

A very good overview of guidelines for siting small wind machines. Includes information on general wind characteristics, the effects of variation in topography and methods of site analysis.

PERIODICALS

The Solar Age, Wind Products Supplement. SolarVision, Inc., Church Hill, Harrisville, N. H. 03450.

Systems specifications for commercially available wind machines.

Wind Power Disgest. ed, Michael Evans
109 East Lexington, Elkhart, IN 46514 (published quarterly)

A very good layman's periodical on wind energy. Includes current information on wind technology, publications and reports on new developments in the field.

* Copies of the above mentioned sources are available for use in the Executive Office of Energy Resources, 73 Tremont Street, Boston, Massachusetts 02108.

Checklist of Items to be Considered When Providing for Wind Energy Conversion Systems in a Zoning Ordinance or Bylaw.

When developing a zoning ordinance or bylaw, and/or procedures and regulations for allowing wind machines either as accessory uses or by special permit, the following items should be considered:

Definitions

Statement of Applicability

Zone or Districts Where Allowed

Permit Granting Authority (for Special Permits)

Tower Height Requirements

- high average wind speeds
- low turbulence
- setback from property lines

Safety Issues

- tower access
- maintenance
- abandonment

Setback Requirements

- blade throw
- ice throw
- tower height

Community and Environmental Impacts

- noise levels
- eletromagnetic interference

Categories of WECS Applications

- single family residence
- commercial on-site use
- wind farms
- large scale commercial applications
- cooperative developments

APPENDIX A

FEDERAL AND STATE AGENCY REGULATIONS

STATE BUILDING CODE (780 C.M.R.)

"Section 101.3 Matters not covered: Any requirements essential for structural, fire or sanitary safety of an existing or proposed building or structure, or essential for the safety of the occupants thereof, and which is not specifically covered by this code, shall be determined by the building official. The State Building Code Commission and the Department of Public Safety shall be notified in writing within seven (7) working days of any action taken under this section."

"Section 110.1 Approved materials and equipment: All materials, equipment, devices, systems or methods of construction shall be subject to the following approvals required by this section."

"Section 110.2 Accepted engineering practice: If not otherwise specified in this code, the regulations, specifications and standards listed in the appropriate appendices shall be deemed to represent acceptable engineering practice with respect to the material, equipment, device, system or method of construction therein specified."

"Section 110.3 New materials and methods of construction: The provisions of this code are not intended to prevent the use of any material, system or method of construction not specifically prescribed by this code. The building official shall accept approvals of the Commission on all new materials, systems or methods of construction proposed for use which are not specifically provided for in this code."

"Section 113.2 Form of application: The application for a permit shall be submitted in such form as the building official may prescribe and shall be accompanied by the required fee as prescribed in Section 118.0."

"Section 113.7 Engineering details: The building official may require adequate details of structural, mechanical and electrical work, including computations, stress diagrams and other essential technical data, prepared by a registered professional engineer qualified by experience in the specific field of construction, to be filed. All such plans and computations shall bear the Massachusetts seal of registration and signature of the qualified registered professional engineer or architect."

LAWS RELATING TO AERONAUTICS, M.G.L. CHAPTER 90 SECTION 35B

No person shall erect or add to the height of any structure within a rectangular area lying fifteen hundred feet on either side of the extended center line of a runway or landing strip of an airport approved by the commission for a distance of two miles from the end of such runway or landing strip so that the height thereof will be more than one hundred and fifty feet above the level of such runway or landing strip, nor, within that portion of such area which is within a distance of three thousand feet from the end of such runway or landing strip, so that the height thereof will be greater than a height above the level of such runway or landing strip determined by the ratio of one foot vertically to every twenty feet horizontally measured from the end of such runway or landing strip, unless a permit therefore has been granted by the commission.

FEDERAL COMMUNICATIONS COMMISSION (47 C.F.R. Part 15)

"Section 15.1 (a) An incidental and restricted radiation device may be operated under the restrictions and provisions set forth in this part without an individual license. The oepration of an incidental or restricted radiation device not in accordance with the provisions herein is prohibited by section 301 of the Communications Act of 1934, as amended."

"Section 15.4 (b) Harmful interference. Any emission, radiation or induction which endangers the functioning of a radionavigation service or of other safety services or seriously degrades, obstructs or repeatedly interrupts a readiocommunication service operating in accordance with this chapter."

"Section 15.4 (c) Incidental radiation device. A device that radiates radio frequency energy during the course of its operation although the device is not intentionally designed to generate radio frequency energy.

"Section 15.25 An incidental radiation device shall be operated so that the radio frequency energy that is emitted does not cause harmful interference. In the event that harmful interference is caused, the operator of the device shall promptly take steps to eliminate the harmful interference.

MASSACHUSETTS ENVIRONMENTAL PROTECTION ACT, M.G.L. CHAPTER 30 SECTION 61

All agencies, departments, boards, commissions and authorities of the commonwealth shall review, evaluate, and determine the impact on the natural environment of all works, projects or activities conducted by them and shall use all practicable means and measures to minimize damage to the environment. Unless a clear contrary intent is manifested, all statutes shall be interpreted and administered so as to minimize and prevent damage to the environment. Any determination made by an agency of the commonwealth shall include a finding describing the environmental impact, if any, of the project and a finding that all feasible measures have been taken to avoid or minimize said impact.

As used in this section and section sixty-two, "damage to the environment" shall mean any destruction, damage or impairment, actual or probable, to any of the natural resources of the commonwealth and shall include but not be limited to air pollution, water pollution, improper sewage disposal, pesticide pollution, excessive noise, improper operation of dumping grounds, impairment and eutrophication of rivers, steams, flood plains, lakes, ponds, or other surface or subsurface water resources; destruction of seashores, dunes, marine resources, underwater archaeological resources, wetlands, open spaces, natural areas, parks, or historic districts or sites. Damage to the environment shall not be construed to include any insignificant damage to or impairment of such resources.

Added by St. 1972, c. 781, § 2. Amended by St. 1973, c. 989, § 4.

DATE: November 30, 1977

ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

SUBJECT: PROPOSED CONSTRUCTION OR ALTERATION OF OBJECTS THAT MAY AFFECT THE NAVIGABLE AIRSPACE

1. PURPOSE. The purpose of this advisory circular is to advise those persons proposing to erect or alter an object that may affect the navigable airspace of the requirement to submit a notice to the Administrator of the Federal Aviation Administration (FAA). It also contains the addresses of the regional offices and availability of associated publications.

2. CANCELLATION. This cancels AC 70/7460-2F, dated January 22, 1976.

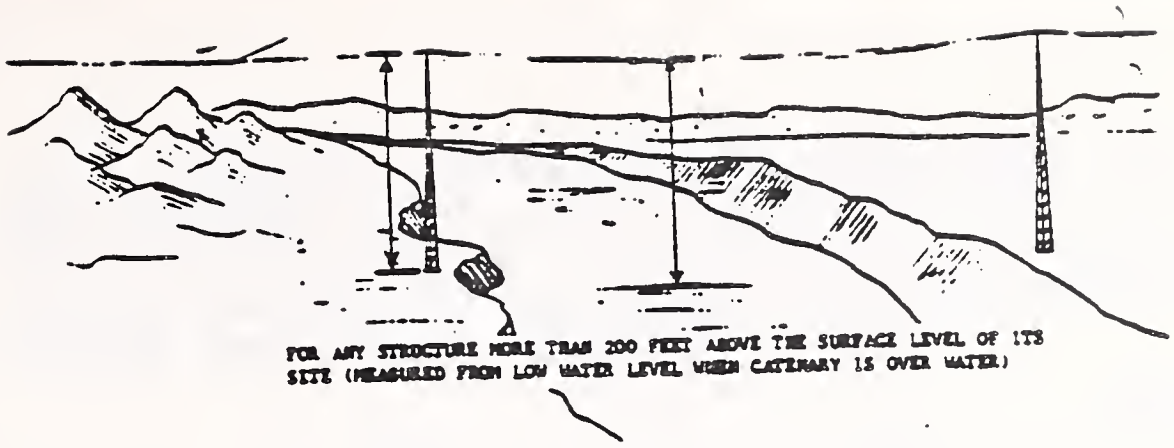
3. KIND OF OBJECTS. The notice requirement criteria apply to the proposed construction or alteration of any structure (building, tower, roadway, overhead wires and their supporting structures, etc.), including any construction equipment employed. These criteria apply to the height of overhead communications and electric transmission lines above the terrain, or water if so situated, as well as the height of their supporting structures.

4. WHO MUST FILE A NOTICE. A construction sponsor is required by regulation[1] to submit notice to the Administrator of the FAA if his proposed construction or alteration exceeds one or more of the following conditions:

   a. Greater Than 200 Feet in Height. If the proposed object would be more than 200 feet above ground level (AGL) at its location.

1/ Persons failing to comply with the provisions of the Federal Aviation Regulations, Part 77, may be liable to a fine of up to five hundred dollars ($500.00) as provided for by Section 902(a) of the Federal Aviation Act of 1958, as amended.

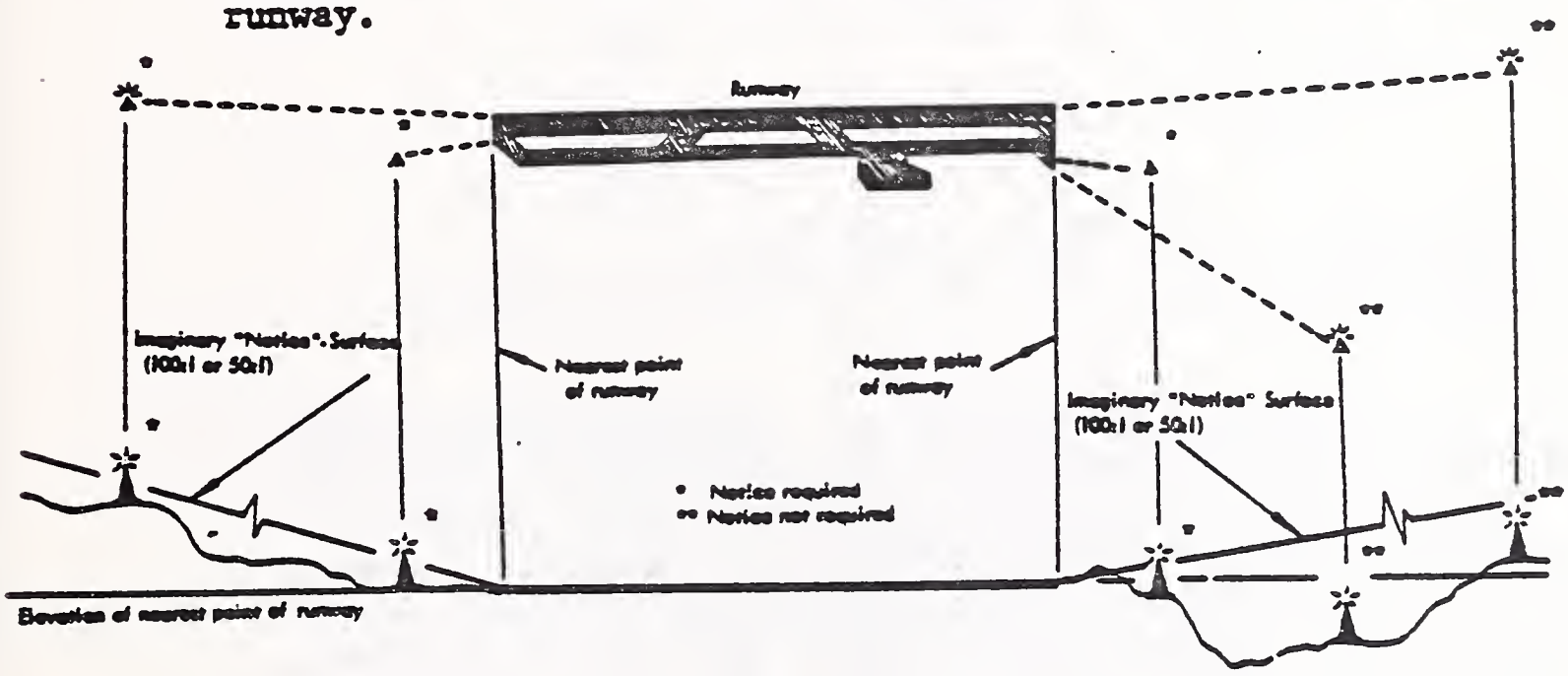
Initiated by: AAT-240



FOR ANY STRUCTURE MORE THAN 200 FEET ABOVE THE SURFACE LEVEL OF ITS SITE (MEASURED FROM LOW WATER LEVEL WHEN CATENARY IS OVER WATER)

b. Near an Airport.[2/]

(1) If the proposed object would be within 20,000 feet of an airport with at least one runway more than 3,200 feet in length; and would exceed one foot in height for each 100 feet (100:1) horizontally from the nearest point of the nearest runway.

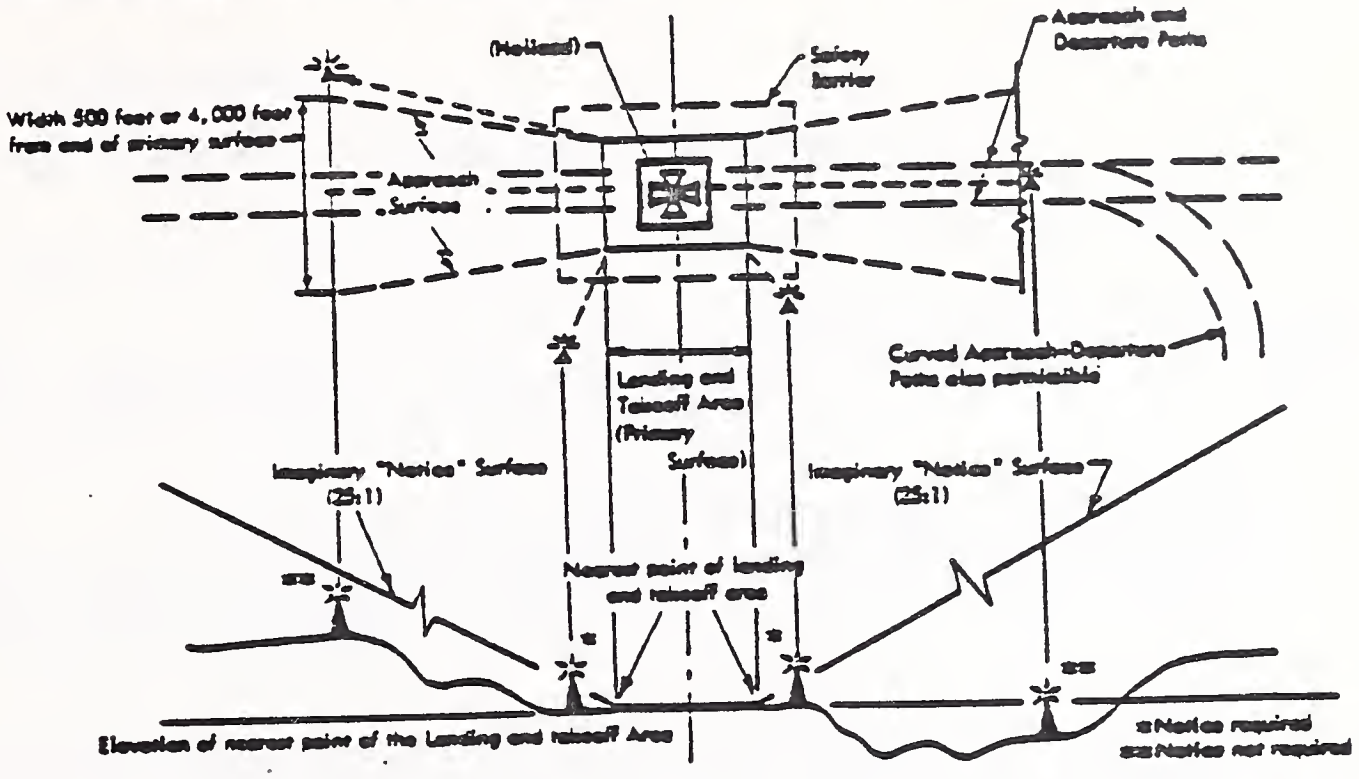


(2) If the proposed object would be within 10,000 feet of an airport[2/] having no runway more than 3,200 feet in length; and would exceed one foot in height for each 50 feet (50:1) horizontally from the nearest point of the nearest runway. (See diagram under item 4b(1))

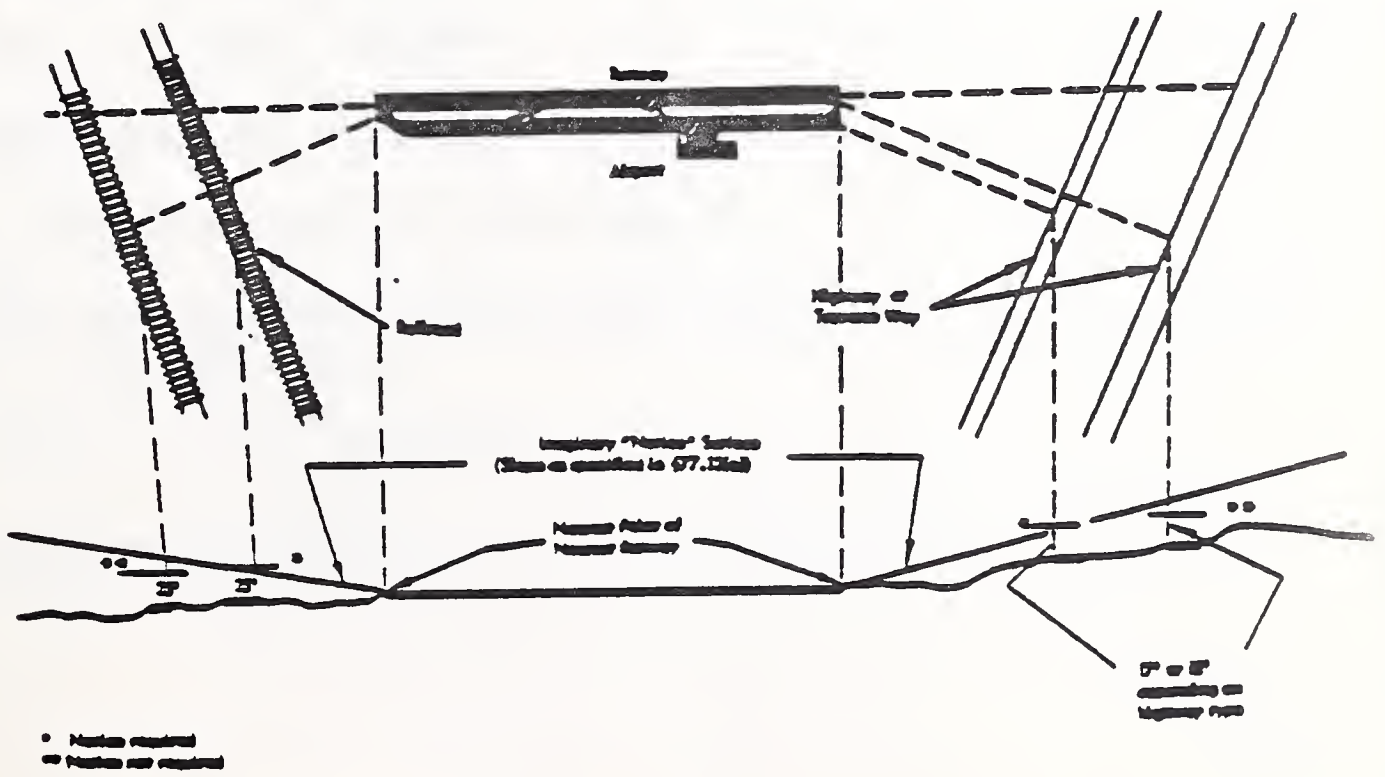
c. Near a Seaplane Base.[2/] If the proposed object would be near a seaplane base, apply item b(1) or (2) above as applicable.

2/ To qualify, an airport, or visually marked seaplane base, must be listed in the "Airport Directory" of the current Airman's Information Manual or in either the Alaska or Pacific Airman's Guide and Chart Supplement or operated by a Federal military agency.

d. Near a Heliport. If the proposed object would be within 5,000 feet of a heliport listed in the "Airport Directory" or operated by a Federal military agency; and would exceed one foot in height for each 25 feet (25:1), horizontally from the nearest landing and takeoff area of that heliport.



e. Highways and Railroads. If the proposed object is a traverse way which would exceed at least one of the standards listed in Items a - d above, after its height is adjusted upward 17 feet for an Interstate Highway, 15 feet for any other public roadway, 10 feet (or the height of the highest mobile objects that would normally traverse the road) for a private road, 23 feet for a railroad, or an amount equal to the height of the highest mobile objects that would traverse a waterway or any other thoroughfare not previously mentioned.



f. Object on an Airport. If the proposed construction or alteration would be on an airport.

g. When Requested by FAA. The FAA may request a notice if available information indicates the proposal may exceed a standard.

WHEN TO FILE A NOTICE. The notice required under Item 4a through g above must be submitted.

a. At least 30 days before:

(1) the construction or alteration is to begin; or,

(2) the application for a construction permit is to be filed.

b. On or before the date the application for construction is filed with the Federal Communications Commission (FCC), if the proposed structure would be subject to FCC licensing requirements.

c. Immediately by telephone or other expeditious means, with written notification submitted within five days thereafter, if immediate construction or alteration is required as in cases involving public services, health or safety.

d. As early as possible, and preferably in the planning stage, for construction or alteration on an airport or near an air navigational facility if the proposal could possibly have an adverse effect on air traffic control operations or an air navigation facility. This includes the effect of the physical presence of structures upon the line-of-sight capability of airport air traffic control towers and the operation of air traffic control radar, as well as the interference effect of electrical signals transmitted by some structures upon ground-based or airborne air navigation equipment.

6. WHY A NOTICE IS REQUIRED. Notice of proposed construction or alteration is required so that the FAA may:

a. Issue notices to airmen (NOTAMS).

b. Depict obstructions on aeronautical charts.

c. Recommend appropriate marking and lighting.

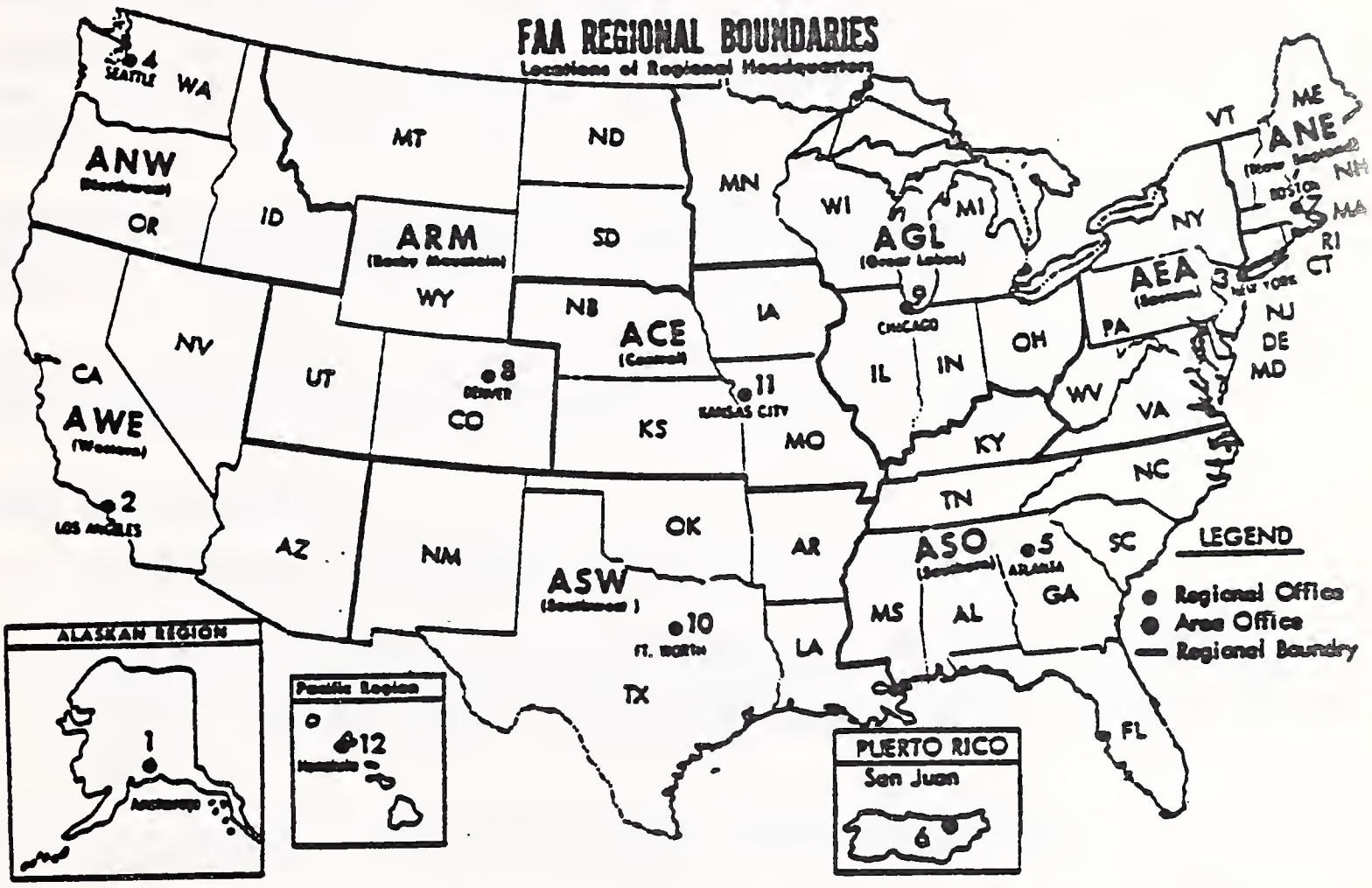
d. Be made aware of potential aeronautical hazards in order to attempt to prevent or minimize them.

e. Insure judicious use of airspace.

f. Protect the lives and property of persons in the air and on the ground.

7. HOW TO NOTIFY FAA. Notification to the FAA may be made by forwarding one completed set of FAA Form 7460-1, Notice of Proposed Construction or Alteration, to the Chief, Air Traffic Division, at the regional office having jurisdiction over the area within which the construction or alteration will be located. In Puerto Rico, notices should be forwarded to the Chief, Air Traffic Branch, San Juan Area Office.

8. WHERE TO FILE A NOTICE. The geographic area of jurisdiction for each FAA office is indicated below:



ADDRESS OF REGIONAL OFFICES AND SAN JUAN AREA OFFICE

1 AAL - ALASKAN REGION
Alaskan Regional Office
632 Sixth Avenue
Anchorage, AK 99501
Tel. 907-265-4271

2 AWE - WESTERN REGION
Western Regional Office
15000 Aviation Boulevard
Hawthorne, CA 90260
Mail Address:
P.O. Box 92007
Worldway Postal Center
Los Angeles, CA 90009
Tel. 213-536-6186

3 AEA - EASTERN REGION
Eastern Regional Office
JFK International Airport
Federal Building
Jamaica, NY 11430
Tel. 212-995-3390

4 ANW - NORTHWEST REGION
Northwest Regional Office
FAA Building, Boeing Field
Seattle, WA 98108
Tel. 206-767-2610

5 ASO - SOUTHERN REGION
Southern Regional Office
3400 Whipple Street
East Point, GA 30344
Mail Address:
P.O. Box 20636
Atlanta, GA 30320
Tel. 404-763-7646

6 SAN JUAN AREA
San Juan Area Office
RFD-1, Box 29A
Loiza Street Station
San Juan, PR 00914
Tel. 809-791-1250

7 ANE - NEW ENGLAND REGION
New England Regional Office
12 New England Executive Park
Burlington, MA 01803
Tel. 617-273-7285

8 ARM - ROCKY MOUNTAIN REG.
Rocky Mountain Regional Office
Attn. ARM-530
10455 East 25th Avenue
Aurora, CO 80010
Tel. 303-837-3937

9 AGL - GREAT LAKES REGION
Great Lakes Regional Office
2300 East Devon Avenue
Des Plaines, IL 60018
Tel. 312-694-4500, ext. 456

10 ASW - SOUTHWEST REGION
Southwest Regional Office
4400 Blue Mound Road
Fort Worth, TX 76101
Mail Address:
P.O. Box 1689
Fort Worth, TX 76101
Tel. 817-624-4911, ext. 306

11 ACE - CENTRAL REGION
Central Regional Office
601 East 12th Street
Kansas City, MO 64106
Tel. 816-374-3408

12 APC - PACIFIC-ASIA REGION
Pacific-Asia Regional Office
1833 Kalakaua Avenue
Honolulu, HI 96815
Mail Address:
P.O. Box 4009
Honolulu, HI 96813
Tel. 808-955-0491

ASSISTANCE.

a. Specialists. Airspace specialists are available in the FAA area and regional offices to provide technical assistance, if required.

b. Maps. Topographical Map Series, 7.5 minute, Quandrangle maps (Scale 1:24,000), showing the shape and elevation of the terrain and selected man-made and natural features of the earth's surface plotted to a definite scale, and geographic coordinates are available for most sections of the country from U. S. Geological Survey, Map Distribution Section, 1200 Eads Street, Arlington, Virginia 22202. A check or money order in the amount of $1.25 for each map should accompany the order. Customers west of the Mississippi should order from: Branch of Distribution, U.S. Geological Survey, Box 25286, Federal Center, Denver, Colorado 80225.

c. Geographic Coordinates and Mean Sea Level Elevations. This information is generally obtainable from the above maps; local zoning boards and surveyors may also be able to provide this information.

9. ASSOCIATED PUBLICATIONS. The following publications contain obstruction criteria, marking and lighting standards and paint specifications:

a. Advisory Circulars.

(1) AC 70/7460-1, Obstruction Marking and Lighting.

Purpose. To describe the standards for marking and lighting of structures such as buildings, chimneys, antenna towers, cooling towers, storage tanks, supporting structures of overhead wires, etc.

(2) AC 150/5345-1, Approved Airport Lighting Equipment.

Purpose. Lists the approved airport and obstruction lighting equipment by model number and the manufacturers qualified to supply products in accordance with the indicated specification requirements.

(3) AC 150/5340-21, Airport Miscellaneous Lighting Visual Aids.

Purpose. To provide guidance for the installation, maintenance, testing and inspection of airport visual aids and the red flashing and steady burning obstruction lighting systems. (It is anticipated that guidance for the installation and maintenance of the high intensity white obstruction lighting system will be included in the next revision.)

Availability. FAA advisory circulars are available free of charge from: Department of Transportation, Publications Section, TAD-443.1, 400 7th Street, S.W., Washington, D. C. 20590.

b. FAA Forms.

(1) FAA Form 7460-1, Notice of Proposed Construction or Alteration.

Purpose. To notify the FAA of the proposed construction or alteration of an object that may interfere with the navigable airspace.

(2) FAA Form 7460-2, Notice of Progress of Construction or Alteration.

Purpose. To notify the FAA of progress, when and as requested on the form. This form will be automatically furnished by the FAA regional office issuing the determination whenever notification is needed for charting purposes and to change affected aeronautical procedures.

Availability. FAA forms are available free of charge from all FAA regional offices. (See Item 8.)

c. Federal Aviation Regulation.

(1) Federal Aviation Regulation (FAR) Part 77, "Objects Affecting the Navigable Airspace."

Purpose. To prescribe the standards for determining obstructions in navigable airspace and to set forth the requirements for notice to the FAA of proposed construction or alteration.

Availability. FAR, Part 77 is available for $1.10 from: Superintendent of Documents, U. S. Government Printing Office Washington, D. C. 20402. Make check or money order payable to Superintendent of Documents.

d. Marking Specifications and Standards. Aviation colors and paint should conform with the following:

(1) Federal Standard Number 595, Color Guide, Ready Mixed Paint.

(a) Orange Number 12197

(b) White Number 17875

(2) Federal Specification TT-P-59, Aviation Surface Paint, Ready Mixed, International Orange.

(3) Federal Specification TT-P-102, Aviation Surface Paint, Oil Titanium Lead-Zinc and Oil, Exterior, Ready Mixed, White and Light Tints.

Availability. FAA standards and specifications are available free of charge from: Business Service Center, General Services Administration, Washington, D. C. 20405.

e. Lighting Specifications.

(1) Aviation Red Obstruction Lighting Systems.

(a) Color. Military Specification MIL-C-25050 Colors; Aeronautical Lights and Lighting Equipment

(b) Rotating Beacons.

1 Military Specification MIL-L-7185 Lamp Assembly, 24-inch, Rigid Drum-Type Rotating Beacon

2 FAA Specification 291 Beacon, 36-inch, Rotating Double-Ended Type

(c) Flashing Code Beacons.

FAA Specification 446 Code Beacons, 300 MM

(d) Double and Single Obstruction Lights.

1 Military Specification MIL-L-7830 Light, Navigational Boundary and Obstruction Markers

2 FAA Advisory Circular Number 150/5345-2 Specifications for L-810 Obstruction Light

(2) High Intensity White Obstruction Lighting Systems.

FAA Advisory Circular Number 150/5345-43, FAA/DOD Specification L-856, High Intensity Obstruction Lighting Systems.

Availability. The lighting specifications listed above may be obtained free of charge from the designated facility.

Military Specifications:

Commanding Officer
Naval Publications and Forms Center
5801 Tabor Avenue
Attention: NPFC-105
Philadelphia, Pennsylvania 19120

FAA Specifications:

Chief, Airports Engineering Division, AAP-500
Department of Transportation
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D. C. 20591

FAA Advisory Circulars:

Department of Transportation
Publications Section, TAD-443.1
400 7th Street, S.W.
Washington, D. C. 20590

11. HOW TO OBTAIN ADDITIONAL COPIES OF THIS ADVISORY CIRCULAR.

a. AC 70/7460-2G, Proposed Construction or Alteration That May Affect the Navigable Airspace, dated 11/30/77.

b. Identify the publication by its full title as in a. above and order from: Department of Transportation, Publications Section, TAD-443, 400 7th Street, S.W., Washington, D.C. 20590. FAA employees obtain copies through normal distribution system.

c. Payment. There is no charge for this publication.

Raymond G. Belanger

RAYMOND G. BELANGER
Director, Air Traffic Service

ACKNOWLEDGEMENTS

This handbook represents the culmination of several months of research and discussion by staff of the Executive Office of Energy Resources working in conjunction with an Advisory Committee on Wind Zoning. Direction for the study was provided by Linda L. Sutliff, Assistant Director for Renewable Resources. The principal author of the handbook was Phyllis Gardiner. Michele Brown and Carol McGuirk were responsible for putting the handbook into final readable form. The cover illustration done by Marcia Sewall depicts a windmill typical of those used in New England from the seventeenth through the nineteenth centuries. The interior illustrations were drawn by George O'Neil.

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Wind machines represent a dispersed energy source which can only be planned for and effectively controlled at the local level. We hope that this handbook will be a useful tool for Massachusetts cities and towns attempting to design zoning schemes appropriate to the fabric of our local communities. My staff and I look forward to providing any help we can to support the efforts of local officials. With their help, we can look forward to increasing use of wind energy here in the Commonwealth.

Joseph S. Fitzpatrick
Secretary of Energy Resources